PERFORMANCE TESTS OF INTELLIGENCE FOR THE ADULT BLIND

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PERFORMANCE TESTS OF INTELLIGENCE FOR THE ADULT BLIND:* A Comparison of Three Measures

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Few developments in the behavioral sciences have had so vast an effect, touched the lives of so many people, as the measurement of "intelligence."

For more than half a century books and journals have been filled with arguments over the definition of intelligence, experiments on how to measure it, and studies of its relationship to just about every other aspect of human behavior. Regardless of disagreement concerning definition, there seems to be much evidence that the information produced by the "intelligence" tests is valuable in many aspects of understanding and working with people and especially in educational and vocational planning and counseling.

Yet we must concern ourselves somewhat with the matter of definition. This report relates to performance tests for blind persons; it seems necessary to clarify what we mean, and perhaps even more what we do not mean, by performance tests.

Confusion In Terminology

Unfortunately, a number of writers of some note have failed to use this term with clarity so that the layman or relatively inexperienced student can scarcely be blamed for confusion in terminology. Perhaps a brief review of the background of the present performance tests will help.

Very early in the study of human abilities, samples of behavior were related to intelligence or what might better be called general mental ability. Binet pulled together a number of such samples into a scale which related mental age (measured by the samples on which the individual succeeded) to chronological age and resulted in the intelligence quotient, or I.Q. At lower age levels Binet and his American adapter, Terman, used some items which involved activity or the use of concrete materials; but most of the items were verbal.

The success of the various forms of the Binet test is well known, but there was soon a recognition of need for less verbal material to measure the ability of individuals who had not had the opportunity to develop verbal

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skills, such as very young children, educationally deprived persons, persons with foreign language background, or deaf persons. Several early workers in this field developed formboards of varying complexity to meet this need.

Then there also seems to have been a growing realization that such performance or concrete materials test could reach, even in a person with normal verbal skills, abilities not tapped through words. To obtain information about these non-verbal abilities, Lightner Witmer devised and adapted three tests of varying difficulty and developed norms by age and grade for levels from pre-school to beginning high school. Similarly, Grace Arthur[1/] developed and revised a point scale of performance tests.

Intelligence Into Three Types

The importance of these measures was given theoretical support by the work of E.L. Thorndike[21/] who divided intelligence into three types: (1) abstract, largely measured by the verbal materials, (2) concrete, measured by the performance tests under discussion, and (3) social, for which no really good measure has ever been developed. Other theorists such as Spearman[19/] and Thurstone[22/] agreed upon a breakdown into factors of special abilities (plus, in Spearman's case, a "g" factor) but were less clear in pointing up the importance of concrete materials; they usually satisfied their need for non-verbal content through diagrammatic or picture material in printed form. Wechsler[27/] gives a good bit of credit to Alexander for his own decision to include measures of concrete as well as verbal content and there is no doubt that the success of the various Wechsler scales, in practical application, was a major influence in establishing the importance of "performance" tests.

Tried to Keep them "Culture Free"

Great as the differences in item content were, all these tests sought to evaluate the ability to perceive similarities and differences, to see relationships, to develop concepts, to solve problems, to integrate parts into wholes, to apply rules, to profit by experience and therefore to learn.

It was also generally characteristic of these tests that an effort was made to keep them "culture free," that is, to measure aspects of mental ability which would be little affected, certainly not largely dependent upon, schooling. This was far more true for "performance tests" than for the various verbal scales which definitely sample such academic items as vocabulary and arithmetic. Thus it might be claimed that the performance tests evaluated a native ability to a greater extent than did the verbal tests.

Frequently, though not invariably, performance scales required the manipulation of materials, but the emphasis was always upon the problem solving, the concept development. Unless the individual was actually handicapped with regard to use of his hands (a spastic for example) his score was very little affected by dexterity. Most subjects require far more time to decide where to move the parts than to perform the actual movement.

The performance scale as it appears in the Wechsler and as it will be discussed in this paper in relation to blind persons is, then, a test of mental operations in the broad or general sense implied by such terms as

"intelligence," "learning ability," or "general mental ability." It is not a measure of manual dexterity, of sheer speed of manipulation on an assignment requiring no problem solving or development of concepts. The performance scale should therefore be clearly differentiated from such tests as the Purdue Pegboard, the Minnesota Rate of Manipulation, the Penn Bi-Manual or the Crawford Small Parts Dexterity. These latter tests have been shown, in many industrial studies (Bingham,[4/] Tiffin[24/]) to relate to success on repetitive manual jobs but they show little or no relationship to success in schooling.

It is also important to differentiate the performance scale from the tests of mechanical aptitude of which there are a number in both printed and concrete form. The mechanical aptitude test presents a number of basic mechanical principles or samples of types of mechanical relationships. Excellent examples of mechanical aptitude tests in printed form are the various forms of the Bennett tests, or the Mechanical Reasoning Subtest of the Differential Aptitude Battery. Less frequently used are mechanical aptitude tests in concrete form such as the Stenquist. These tests usually have some positive correlation with performance skills but their intent is to measure what Thurstone would designate as one of the special abilities, mechanical comprehension, while the performance scale seeks to measure problem solving and learning ability of a more general, non-specialized nature.

Performance Tests for Blind Persons

Early efforts to measure the general ability or intelligence of blind persons were completely in verbal form. The Hayes-Binet resulted from a deliberate selection of purely verbal items, with omission of all non-verbal content, from forms L and M of the Binet. With blind adults the various Wechsler Verbal Scales were used, while the Wechsler Performance Scales were, of course, omitted because none of the tests could be done without some vision. Many workers with the blind expressed regret at the limited and completely verbal character of psychological information thus made available, a regret which was all the greater because there are several reasons why Verbal I.Q.'s might be less truly representative for blind than for seeing persons. Cutsforth[5/] and others felt that many blind persons developed a pseudo verbal skill which might inflate Verbal I.Q.'s, a show of prowess with words which covered very bare and limited concepts. On the other hand, until rather recently, many blind children were neglected in school, consequently dropped out early and might correctly be called educationally deprived. As a result their Verbal I.Q.'s were likely to be lowered, and therefore to underestimate their true ability.

It is true that in the years just before World War II both Hayes[9/], in Massachusetts, and Stephenson Smith, in Washington, did some experimental work toward developing a performance test but their results did little more than whet the appetite for concrete materials; no finished tests were produced.

At the 1947 convention of the American Association of Workers for the Blind, Bauman[2/] reported on a non-language learning test which has, since that time, been used by her and by a small number of psychologists trained by her or influenced by her work. This is specifically designed to measure the subject's improvement, through three successive trials, in ability to follow rules, ability to work with moderately complex form relationships,

and therefore ability to develop concepts in concrete form. In the hands of skilled persons, it can make a great contribution to understanding of abilities which the Verbal I.Q. is quite incapable of reaching. However, Bauman has always spoken of this as a clinical instrument, rather than a test, implying that the observations of a trained examiner are far more important than speed scores. In part, this is because small amounts of residual vision can greatly affect test results and no way was ever found to translate visual differences into reliably differentiated norms.

A number of efforts have been made to adapt the Kohs Design Blocks which are, of course, also a familiar subtest of the Wechsler Performance Scale. The ease with which the color differences of the original blocks can be translated into tactual differences seems to have great appeal.

In 1956, Wattron[26/] reported the results of a Master's Thesis study in which he adapted the Kohs material by roughening sections of wooden blocks. He developed problems of increasing difficulty similar to those of Kohs and tested 20 blind subjects. He found a Spearman rank-difference correlation of .84 with Hayes-Binet I.Q. and concluded that this material offered enough promise to warrant further study.

In Japan, Ohwaki[14/] adapted the Kohs Blocks by covering them with fabrics and he has developed extensive norms on the Japanese population. Currently, Sakata and Sinick[15/] are including the Ohwaki blocks in a battery of tests from which they propose to develop a performance scale. Other items in the Sakata-Sinick Scale are embossed tests of spatial relations, a peg-board, and the O'Connor Wiggly Block (a three dimensional test which was popular during World War II). They state that preliminary work has been done with these materials.

In 1952, MacFarland[12/] reported on the use of mazes and concluded on the basis of his exploratory work that the maze procedure might be a valuable measure of learning ability, but he did not actually attempt to develop this into a test in the formal sense. For some years, Newland[13/] has been discussing possible items of a performance test, but he has evidently not found opportunity to make it a reality. In a publication as recent as December 1964, he again describes possible items but only as illustrations of symbolic thinking. Earlier in 1964, Foulke[6/] described a very interesting and novel approach to use of concrete materials. One of the contributions of his test is that it is apparently designed for relatively young children, an age level for which so few materials are available at present. However, his report also shows only preliminary study with 30 children and it is not clear whether he plans to continue the work or whether he regards his material as capable of extension to use with older subjects. Anderson made very ingenious copies of the Raven Progressive Matrices in tactual form but abandoned the project when he found so high a correlation with the WAIS Verbal Scale that almost no new information was gained by this very time-consuming adaptation.

Fortunately, it is possible to report that two projects, both supported by grants from the Vocational Rehabilitation Administration, have reached completion and as a result three new measures are available, along with instructions for their use and data to aid in their interpretation. The study reported in this paper is a comparison of these three measures. Since very full descriptions of these tests are available (7, 8, 10, 11, 16, 17, 18, 20, 23)

we will include here only the minimum information necessary to understanding this study and the resulting comments.

Haptic Intelligence Scale

Between 1954 and 1956 H.C. Shurrager, P.S. Shurrager and S.B. Watson worked on the development of a five-test scale which they called the Performance Scale for the Adult Blind, which was reported in Watson's dissertation.[25/] Their results were sufficiently encouraging to lead to support for a larger project which, after some changes in items, has resulted in a six-test scale designated by the name Haptic Intelligence Scale for the Adult Blind.[18/]

Although they disclaim any aim precisely to adapt the Performance Scale of the Wechsler, four of their subtests, in tactual form, resemble the Digit Symbol, Block Design, Object Assembly, and Picture Completion tests of the Wechsler Performance Scale. Their fifth test, the Pattern Board, consists of a square board with 25 round holes in rows of five. By inserting pegs into certain holes, the examiner forms a pattern around a fixed center peg, allows the subject to examine this pattern, then removes all but the center peg and asks the subject to reproduce the pattern from memory. Their sixth test, called Bead Arithmetic, involves use of an abacus; the subject is taught the basic principles of its use, then is asked to do simple problems on it.

To facilitate use of this scale in conjunction with the WAIS Verbal Scale, normative data is based on age categories and statistical treatment patterned on the WAIS. Their normative group is made up of 700 blind persons varying in age from 16 to 64 years, 100 in each of the age categories used by Wechsler for his WAIS norms. By careful selection they managed to have each age group exactly divided between male and female subjects and the maximum variation in mean WAIS Verbal I.Q.s, from group to group, is less than one point. At each age level subjects were also carefully chosen from the northeast, north central, southern, and western sections of the country to duplicate the proportions of the general population in those areas, with concern for the typical rural-urban balance of that section. Other descriptive information concerning the normative sample, detailed in the HIS manual, suggests that it is closely representative of blind persons of employable age. The authors of the test are to be congratulated both for the obvious effort on their part to obtain a representative sampling and for the fullness with which they report the descriptive information.

Because even small amounts of vision (within the definition of legal blindness) markedly change responses to the test items, an effort was made to limit the normative group to totally blind subjects, and in cases where some useful vision existed the subject was blindfolded. Consequently, the manual states that "there are no norms for the partially sighted and the exercise of useful vision invalidates norms established with the totally blind."

There is a suggestion that, in the hands of an experienced examiner, useful information might also be obtained regarding partially sighted persons.

Test-retest and odd-even relationships for the individual tests vary from .70 to .94 and would generally be regarded as adequate. Intercorrelations

of the HIS subtests are fairly high, suggesting that while each measures some unique element, there is also a relatively large common factor. Similar high intercorrelations were found among manual dexterity tests by Bauman[3] and there is some reason to believe that tactual, orientation and other factors increase this weight of common elements measured for blind persons, compared with sighted subjects.

Correlation of HIS tests and total score with WAIS total Verbal scores are a little lower than the correlations of WAIS Performance with WAIS Verbal results for seeing persons. In other words, the two WAIS scales may be measuring more common factors than are the HIS and WAIS Verbal scales.

VISAB and TRP

In an interesting combination of doctoral projects at Purdue University, under the direction of Tiffen,[23] two separate tests were developed by Jones and Gruber. These have been given detailed analysis, and manuals have been developed for them by Teare.[20]

Jones' test, called the Vocational Intelligence Scale for the Adult Blind (VISAB), consists of 43 series of geometric patterns in raised form. For each series the subject is asked to identify the one least like the other three. The similarity of this to certain printed tests, such as the SRA Non-Verbal Form, is obvious.

Gruber's test, called the Tactual Reproduction Pegboard, asks the subject to reproduce on one half of a metal pegboard the patterns constructed by the examiner on the other half of the board. The subject may refer to the sample as frequently as he wishes. Both accuracy and rate of placement are scored.

Statistical studies are based on between 500 and 600 people, between ages 20 and 50, from several centers in the middle west and from New York City. Individuals were described as competitively employed, sheltered shop employees, unemployed, agency personnel and vending stand workers. A rather heavy loading of the population with sheltered shop workers reflected the origins of this project in a request by the National Industries for the Blind for assistance in understanding their workers.

Among validation criteria were supervisory ratings for the sheltered shop employees, grouping into levels of competitive employment, etc., salary, and a job hierarchy which rated vocational achievement on a scale from professional to the routine labor levels.

The authors report a correlation between VISAB and WAIS Verbal I.Q. of .63, while the correlation between TRP and WAIS Verbal I.Q. is .39. Validity studies resulted in some contradictions, but the authors claim that while the WAIS Verbal I.Q. proved generally the best overall predictor of success and correlated best with the salary and job hierarchy criteria, the performance tests were better predictors of success in repetitive manual tasks and related best to the supervisory rating criterian.

Again, excellent background information with regard to the normative groups is provided and validity and reliability information is satisfactory.

Norms are provided in terms of employment groups, vision groups (80-90% loss, 91-99% loss, and L.P.-Total), and age of onset.

The Comparative Study

This study was motivated by very practical considerations. When new test material promises additional understanding of clients, the responsible professional worker will naturally wish it added to the test battery. However, limitations in both examination time and the energy of the client make the addition of all three of the above tests impossible when the basic battery for the examination of blind clients is already lengthy. Some choice must be made.

It was therefore agreed by some of the state agencies served by the Personnel Research Center that we should administer the three new tests to clients already examined with our standard battery, and upon whom reports had already been written. This would make it possible to determine what, if anything, the new tests added and might make it possible to choose among them. Since the standard battery includes the Non-language Learning test, this procedure would also make possible a comparison between its results and the new tests.

Procedure for this study therefore involved:

1. Selection by the agencies of clients to be given the additional tests. This selection was largely on the basis of availability; that is, the client's case was still active. Some additional persons were included in the statistical study when opportunity arose to test applicants for certain forms of training where the performance tests seemed particularly relevant; this latter group of college level individuals pulled the mean for the WAIS Verbal I.Q. up to 111.11 (SD 14.9). Subjects varied in age from 16 to 54 years with a mean of 28.6 (SD 9.5). To avoid differences resulting from varied amounts of vision, only persons without useful vision were included.

2. Administration of the three new tests and interpretation by the psychologist.

3. Meetings with the agency staff who compared what they had learned from the original psychological reports and the new information, to evaluate what was gained from the three new tests.

4. Statistical study of the three tests and of relevant relationships among the quantitative data.

5. To obtain a less biased evaluation, a psychologist with long experience in the interpretation of data for blind persons, but with no connection with the Personnel Research Center or the state agencies, was asked to compare the test results and reports from the original examination, using the basic battery, and the data from the three new tests.

Only item 4 will be reported in detail here. Table I shows the intercorrelations of the three new tests and their relationship with WAIS Verbal I.Q. for our population. As we worked with this material, we became interested in the

possible relationships among the tests if the effect of WAIS I.Q. were held constant; Table I also shows the results of these partial correlations. For the VISAB and TRP our correlations approximate those reported by the authors (if we compare our WAIS-TRP correlation with that reported by Gruber for his low vision group). Our data yields a much lower correlation between HIS and WAIS than is reported by Shurrager. We are at a loss to explain this although our population obviously differs from hers in at least two ways: the greater percentage of persons with high WAIS Verbal I.Q.s and the fact that all of our clients were without vision as a result of natural causes whereas some of hers were blindfolded. The somewhat lower partial correlations show that the quality measured by WAIS Verbal I.Q. does have some effect, especially in the relationship between VISAB and TRP. What stands out, however, is the fact that all three of the performance tests have a great deal in common.

Casual observation suggested that it might be interesting to study the relationships of our tests with the WAIS Arithmetic subtest, the Penn Bimanual Assembly (a measure of manual dexterity), and age. These results appear in Table II. The most interesting thing here is the strong relationship between Arithmetic and TRP, and this was supported by our observations since it was obvious that, in most cases, clients handled this task by counting holes in each direction; those who could readily manage these numerical relationships had a great advantage. All of the tests have a moderate element of manual dexterity, although further study would be required to determine whether this is dexterity, in the usual sense of that term, or whether it measures also the elements of orientation in a work space, tactual discrimination, etc., so important to the blind client. There is very little relationship with age, but younger persons have a slight advantage on the VISAB and TRP; since HIS norms are based on age, it was not included in this section.

Table III shows the correlations of VISAB and TRP with the various HIS subtests. Fairly strong positive relationships are evident as might be expected since the HIS total correlates so strongly with VISAB and TRP.

Correlations of the three performance tests with the total score of the Emotional Factors Inventory, and with the Mechanical, Computational and Scientific scales of the Kuder Preference Record are all insignificant. Curiously enough, however, the correlations with Computational interest are consistently higher than the others (HIS .33, VISAB .27, and TRP .32) again suggesting some relationship with numerical functions.

TABLE 1. CORRELATIONS (PEARSON R) BETWEEN WAIS VERBAL I.Q., HIS I.Q., VISAB AND TRP SCORES (N - 50)

				With WAIS constant	
	HIS I.Q.	VISAB	TRP	VISAB	TRP
WASI I.Q.	.44	.58	.66		
HIS I.Q.		.76	.80	.68	.76
VISAB			.63		.49

TABLE 2. CORRELATIONS (PEARSON R) OF PERFORMANCE TESTS WITH WAIS ARITHMETIC, PENN BI-MANUAL ASSEMBLY, AND AGE.

	WAIS Arith.	(N)	Assembly	(N)	Age	(N)
HIS I.Q.	.20	44	.65	43		
VISAB	.29	39	.49	42	-.22	57
TRP	.56	43	.42	43	-.29	57

TABLE 3. CORRELATIONS (PEARSON R) OF VISAB AND TRP WITH HIS SUBTESTS (N-56)

	Pattern Board	Block Design	Object Assembly	Object Completion	Digit Symbol	Bead Arithmetic
VISAB	.80	.75	.63	.56	.62	.68
TRP	.73	.68	.49	.42	.72	.71

Discussion

Although we have learned something about what these tests have in common, it is also clear that each has some unique qualities and the decision regarding which tests, and how many tests, shall be used will depend upon the purpose of the testing. If we are seeking information as different as possible from that provided by the WAIS Verbal Scale, we can best find it through use of the HIS. However, much further study will be required before we shall be able clearly to relate the HIS I.Q. with success in various jobs. Also, the fact that the HIS provides norms only for persons without useful vision limits its value to work with no more than a third of the clients of most agencies.

The varieties of normative data made available by Teare for the VISAB and TRP greatly enrich their usefulness. However, in actual practice we found that some clients, and especially those in the lower ability levels, simply could not comprehend these two tests and they expressed so much frustration with them that it became necessary to abandon testing to avoid such a breakdown in rapport that the client could accomplish nothing more with us. This is one reason for the heavy weighting of persons with high Verbal I.Q.s in our study.

The HIS material seemed much more acceptable to persons of all I.Q. levels and the variations in tasks, moving from one subtest to another, held interest and increased motivation, whereas individuals who began having trouble with the VISAB and TRP seemed to lose motivation even when not so frustrated that they could not go on at all. Also, the variety of tasks in the HIS gave the examiner a wider opportunity to observe the client meeting different problems and reacting to different stimuli; therefore qualitative notes on the examination were much richer.

It has already been noted that this study included evaluation of new information obtained from the three performance tests, both informal evaluation by agency staff and more formal evaluation by a colleague not

otherwise associated with the project. Neither evaluation can be put into any numerical form since, despite efforts to the contrary, it might include some bias, and it is important to remember that the results of the new tests were measured against reports which included use of the Non-language Learning Test. Both the staff and colleague evaluations indicated minimal gains from the new tests; however, we all strongly feel that this would not have been true had the Non-language Learning Test not been part of the original battery. We feel that any or all of the new tests would add greatly to the information available to a psychologist who, up to this time, has used no concrete measure of general ability.

Summary

1. Against a brief background discussion of performance tests, three new measures are described, the HIS, VISAB, and TRP.

2. These three tests were studied, using a population for which results of a standard battery of tests were already available.

3. Correlations with WAIS Verbal I.Q. varied from .44 to .66, while intercorrelations among the three tests varied from .68 to .80. Some positive relationship was found between all HIS subtests and the VISAB and TRP. Positive relations are also found between the three performance tests and a measure of manual dexterity. Relationships with WAIS Arithmetic are minor except for TRP where the r is .56. Relationships with age, Kuder Mechanical, Computational and Scientific scores, and the Emotional Factors Inventory are low.

4. Advantages and disadvantages of the several tests are discussed.

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